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THE BENEFITS OF PRESERVING ENDANGERED SPECIES: WITH SPECIAL ATTENTION TO THE HUMPBACK WHALE (INCLUDING COMMENTS AND RESPONSE)

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Not for Publication

ADMINISTRATIVE REPORT H-85-9

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Southwest Fisheries Center Administrative Report H-85-9

THE BENEFITS OF PRESERVING ENDANGERED SPECIES: WITH SPECIAL ATTENTION TO THE HUMPBACK WHALE (INCLUDING COMMENTS AND RESPONSE)

Robert O. Mendelsohn
School of Forestry and Environmental Studies
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October 1985

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PREFACE

In the summer of 1984, Robert O. Mendelsohn of Yale University spent 2 months at the Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service (NMFS), as a visiting economist. The purpose of his visit was to examine theoretical and methodological questions concerning the economic valuation of species preservation in the context of Hawaii's endangered monk seal and humpback whale populations. Mendelsohn's report, which is included here in its original form, was released in September 1984. At that time, a number of people in the fields of economic valuation and marine mammal ecology were asked to prepare anonymous comments on his report. The idea was that the issues raised in this report manuscript were sufficiently interesting and provocative that a written discussion would make a considerable contribution to research and management of endangered marine mammals.

Eleven people chose to respond formally to Mendelsohn's manuscript. (A number of others made informal comments.) They are listed alphabetically on the page following this preface. The reviewers' comments, which are presented in random order, were sent to Mendelsohn without attribution for his response. He has chosen to make a succinct reply which lets the reader join the discussion.

Mendelsohn's response leads off this revised report, followed by the 11 reviews and the original text (page numbers intact). References from reviewers are combined at the end of the report.

The span of reviews was rather large and many sent personal comments concerning the applicability of economic assessment of environmental issues or the appropriateness of Mendelsohn's criticisms of empirical research in endangered species valuation. One reviewer recommended that Mendelsohn's report be thoroughly revised before release, but this is not an "official" NMFS handbook on valuation methodologies. Another reviewer, Jack Knetsch of Simon Fraser University, asked specifically not to be anonymous in the final compilation. Knetsch has been investigating problems of large empirical differences between willingness-to-pay and willingness-to-accept compensation estimates of nonmarket valuation and believes that the theoretical findings suggested by Willig's seminal article (Willig 1976) fail to represent the deeper psychological differences in people's attitudes toward public resources. Knetsch's review is No. 4.

At the time of the original release of Mendelsohn's report, I expressed the hope that his work would provide the basis for developing more rigorous criteria for evaluating preservation benefits. I had also hoped that the Honolulu Laboratory would be able to contribute to the empirical measurement of such values. The latter did not come to pass, but Dr. Karl Samples of the University of Hawaii's College of Tropical Agriculture (Department of Agricultural and Resource Economics), has just begun a Sea Grant funded research project on the economic benefits and costs of marine mammal preservation in Hawaii. From recent experimental work, Samples is aware of the problems cited by Knetsch and he is also wary of the conceptual problems posed by Mendelsohn. Therefore, the utility of

Mendelsohn's and the reviewers' work may be realized indirectly. The need for an interplay between empirical investigation and conceptual clarification is indicated not only by findings such as those by Knetsch and Samples, but also by questions concerning the foundation of economic valuation. Of this, I will only cite the recent article appropriately entitled "Were the ordinalists wrong about welfare economics?" (Cooter and Rappoport 1984) as an example of the issues reaching currency.

Mendelsohn's research was part of a Southwest Fisheries Center economics fellowship which is designed to give university faculty members the freedom to explore issues of relevance to our economics program. As such, it emphasizes the academic freedom of its participating scholars. Mendelsohn's report and response received minimal editing. The same holds true for the reviewers of Mendelsohn's original report.

Each reviewer deserves substantial thanks for the serious nature of their comments and the attention he or she applied to the topic. Mendelsohn also deserves thanks for extending the range of his fellowship from a brief stay in Hawaii to responding cheerfully to the "slings and arrows" of the reviewers.

Because this work was prepared by independent researchers, their statements, findings, conclusions, and recommendations are those of the authors and do not necessarily reflect the view of the National Marine Fisheries Service.

Samuel G. Pooley
Industry Economist
September 1985

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RESPONSE TO COMMENTS

Several anonymous reviewers have made a series of comments on the manuscript. Several of the comments are well taken, designed to correct factual errors and provide a broader perspective. Other comments suggest that the original manuscript is sometimes misleading, leading to some common misunderstandings. The ideal response is simply to revise the manuscript, correct the errors, and more carefully explain the areas of grayness. Short of an entire revision, however, a few responses may clarify the errors and remaining points of contention.

First of all, let us clarify what are the benefits of preserving endangered species. We define the total value of maintaining a species on Earth as its preservation value. This preservation value has two major components, use and nonuse value. Use value comes from all direct interactions with the species. Thus, use value includes both consumptive and nonconsumptive interactions between man and the target species. Consequently, if a hiker or birdwatcher liked an area he visits because the area harbors an endangered species he values, that aesthetic or even religious value will be reflected in use value. Use value is not limited to hunters and trappers and it most certainly is not limited to narrow definitions of economic value (the market value of the meat, fur, or other parts of the species).

Nonuse values are so labeled because the values do not involve any interaction between the species and the holder of the value. Proponents of nonuse values argue that these values must be added to use values in order to determine total preservation values. Consequently, in order to avoid double counting use values, it is important that nonuse values be narrowly defined not to include use values at all. For example, one use value of a species is that it will provide a flow of aesthetic and recreational values indefinitely into the future. One keeps a species alive not only for today's enjoyment, but also for the expected flow of enjoyment into the future. In contrast, some authors argue that bequest value is a nonuse value because it involves an interaction between the species and generations which do not yet exist. Asking people the bequest value of a species, how much they would pay to keep the species around for future generations, however, is terribly close to asking what is the present value of the future flow of enjoyment from the species. Such a question, as it is currently asked, must surely include use values and consequently, is not a pure nonuser value. Similar complaints can be lodged against measures of existence and option value. As these questions are currently worded, it is highly likely that they include user values. That is not to say that researchers in this area are necessarily dishonest. The purpose in stating these criticisms was to alert readers that this methodology is deceptively difficult to implement, that published results are not necessarily reliable, and that these same results are probably biased upwards. Whether or not nonuse values are truly small remains an open empirical question.

Another interesting misunderstanding surrounds the value of a species under uncertainty. Some authors, for example, suggest that one should not develop large jungle areas because there might be a valuable species in

there which we have not yet discovered. The value of the jungle, they argue, is equal to the value of all the species in it as though we have costlessly gained perfect information about each species. In fact, however, we know very little especially about the lower order species that are destroyed in jungle clearing. What society loses when a jungle is cleared is not the certain value of all the information in that jungle, but rather the opportunity to gather that information. Thus, if there were teams of research scientists combing the world looking for an acre of jungle to study, this lost opportunity may be great. On the other hand, if vast acreages of jungle are ignored because there is an overabundance of opportunities to study jungles, then the actual loss when the jungle is cleared is small. The expected value of the information is the difference between what one is likely to find in a particular acre and what it costs to find it. The vastness of opportunities to study jungles and the low expected return from such studies implies that the information in an average jungle acre is not great.

One reviewer questions whether it is more appropriate to ask willingness-to-pay to protect a species or compensation for the loss of a species. It is not clear who owns the property rights to a species or habitat. Do the developers own the rights and require compensation for species protection or, do the proponents for the species or the species itself own the rights? Luckily, the valuation question is largely independent of this equity issue. Because the protection of an individual species is likely to represent only a small fraction of the incomes of most people, willingness-to-pay should be within a few percentage points of willingness-to-sell. The fact that contingent valuation surveys have been unable to arrive at this result is a reminder of just how difficult it is to ask attitudinal survey questions which reflect true values.

Another general response by reviewers is that they can't see why one should bother measuring the benefits of preservation. The reasons cited are tautological: (1) Decision makers don't have to measure benefits now so that if they did, it wouldn't make any difference; and (2) Current measures are not well developed so that measurement is fruitless. However, the purpose of benefit measurement is not that it is mandated by law, but, that it could lead to more effective management. Both in terms of obtaining more resources for preservation and in allocating those scarce resources across species, measures of benefits would help lead to more rational decisions. Obviously, if one does not try to measure benefits, one will not have good measures of benefits. That is not to say that good measurements could not be developed once some effort is devoted to the subject.

Finally, some comments were oriented more to the underlying ecology than to the valuation methods themselves. One worthwhile comment is whether it is appropriate to single out species at all, or whether instead, the target unit should be a local ecosystem. This is clearly an important empirical issue. Except in rare circumstances where there is a highly visible species on the top of a food chain, most people may have stronger preferences for ecosystems than for individual species. Rather than having laws which protect lower order species, it may be more effective to attempt to protect certain types of habitats. Not only may this conform to

people's values more closely, but it will often simplify the management task of preservation significantly.

Another comment on the ecology which is worth emphasizing concerns the valuation of migratory species. The value of a migratory species is the sum of the values it provides to users throughout its route. Thus, for example, the value users place upon the wintering home of the whooping crane is just a part of the total value of the species. Obviously with birds and whales which have such large ranges, it is important to account for the value these species add to several disparate locations.

Robert O. Mendelsohn
May 1985

REVIEW 1

Dr. Mendelsohn's report on the subject is thought-provoking. I do, however, have reservations as to the worthwhileness and practicality of undertaking empirical research in an attempt to actually measure economic benefits associated with preserving the endangered humpback whale and Hawaiian monk seal. Economic values are not considered to be relevant by U.S. law when it comes to making judgments for preserving endangered species. The implementing guidelines of the Endangered Species Act unequivocably require that all endangered species should be spared from extinction regardless of the relative economic values that society may place on them. In fact, I seem to recall that the implementing guidelines expressly prohibit consideration of economic factors from entering into decisions for listing of species as being endangered in the first place. Rather, the right of existence of species is the criteria that comes into play in the listing process.

I do not believe that a derivation of relative economic values associated with humpback whales and monk seals would make any difference in the funding or the nature of preservation programs for these two species. Factors other than economics would continue to shape agency programs for these two species.

I personally believe that there should be more social value attached to humpback whales than there is attached to Hawaiian monk seals. That is the way it should be since very few individuals have opportunities to interact (directly or indirectly) with the monk seal of the Northwestern Hawaiian Islands. The adage "out of sight, out of mind" should ring true for monk seals. But that is not the way it plays when it comes to funding priorities. I would hazard to guess that when all is added up, more money has been spent to date on monk seal preservation programs than on preservation efforts for humpback whales. This is so not because monk seals are socially worth more than humpback whales but simply because monk seals are of the right size for different preservation "treatments" thought up by biologists. The monk seal recovery plan includes a whole shopping list of things to do to preserve the animals, while I have yet to see any comparable efforts undertaken on the welfare behalf of the humpback whales--other than an ill-conceived national humpback whale sanctuary proposal off Maui that recently got shot down by the Hawaii Governor's office.

It might be possible to empirically measure economic values that society might place on whales and monk seals but for what end? I doubt that a more rational allocation of scarce resources for endangered species preservation would happen as a result.

REVIEW 2

As a concise taxonomic report on perceptions of use and on valuation alternatives, Mendelsohn's report will be very useful, particularly to the noneconomist. However, I am concerned that it finds itself on the wrong foot, concerning the principal focus of the analysis.

While my empirical findings tend to support the author's position that indirect marine values may not loom large in the total value scheme, dismissal of existence value on the same basis is not as persuasive. In fact, close reading of endangered species legislation reveals little of the strict utilization bias of the author-quite the opposite. Thus, the economist may believe that endangered species legislation should be there principally so we can build stocks back for future use, but "preservation" seems, in fact, to stand by itself, with use, or nonuse, a decision to be considered later. With respect to preservation (existence) values, the author may find it easy to be skeptical about the empirical results he presents, and similar work elsewhere, but provides neither contrary empirical evidence nor logical construct to support relegation of existence values to the back burner. Conversely, it is likely that existence values associated with endangered species relatively highly placed in the food chain may be found significant in most cases.

In endangered species valuation, typically an evaluation of potential/ real economic loss or of the benefits of stock maintainence at minimum levels, suggestion of willingness-to-pay as an appropriate contingent value tool is simply wrong-contravening both economic and legal principles (Desvousges et al. 1983; Huppert 1983; Knetsch 1983). Utilization of such a willingness-to-pay approach provides the types of values identified for whooping cranes on pages 5-6 of the author's paper. These values represent a major undersestimate of the value of the endangered species being analyzed, (Kahneman and Tuersky 1979; Meyer 1979; Schulze et al. 1981) relative to a more comprehensive compensatory approach to payment received or to price. In short, this means that use of direct willingness-to-pay or indirect travel expense oriented market simulation techniques such as travel cost or hedonic travel cost will result in significant underevaluation to endangered species. Thus, the author's paper provides a useful taxonomy of value categories, but stops short of providing a theoretically and legally appropriate and procedurally sound approach to valuation of the humpback whale.

It should be made clear that where "endangerment" may be overstated, and the real issue is one of alternative use (i.e., a group of people don't like to see fishing boats in areas where whales are present and believe they can use the Endangered Species Act to keep the fishing group out), then the willingness-to-pay contingent valuation approach suggested by the author applies fully. It is possible that this latter situation is sometimes found in Hawaii and that gear or season restrictions, or other management controls may sometimes be more appropriate to avoiding whale mortality than use of the Endangered Species Act. Alternatively, use of compensatory analysis seems clearly required for endangered species analysis, and use of willingness-to-pay will not only substantially understate the endangered case, but will also establish an adverse precedent concerning undervaluation of any western Pacific fishery where compensation may subsequently be sought from foreign fleets or otherwise. It is suggested, then, that one must initially decide whether the fisheries-related or other action under consideration, in fact, endangers a species that is on the endangered species list. If it does not, the procedures suggested by the author will be appropriate. If it is a case of real endangerment, then a valuation approach more consistent with compensatory principles will be required.

REVIEW 3

The Stoll and Johnson (1984) study of whooping cranes was the first to elicit benefit valuations from both nonconsumptive users and nonusers for an endangered animal species. Their approach, a contingent valuation survey, can be applied to the problem of valuing societal benefits associated with marine mammal populations. However, the whooping crane study looks at one isolated bird species which is very endangered and which imposes no perceptible direct costs on human activity. Furthermore, respondents were aware of the exact location of the whooping cranes if non-consumptive use (observation) was desired. Some of these circumstances will be true for some marine mammals; however, accessibility to marine species in the wild may be limited. Indirect exposure through television and books may differ from that experienced with whooping cranes. Thus, the willingness-to-pay measures obtained in the whooping crane survey cannot be expected a priori to apply to marine mammals.

Mendelsohn has compiled an appropriate list of relevant benefits (Table 1). After a generally persuasive discussion of each, Mendelsohn argues that only use values are relevant for measurement of the benefits of preserving endangered species. The utilitarian argument is that all other values, such as option value or existence value, are in fact use values captured in benefits elsewhere. For example, the argument is posited that existence value does not exist, and that if people were allowed no information on the animal stock (precluding of course visits in the wild, but also media information), then willingness-to-pay for blind faith in the animals' continued existence would be zero.

We take issue with the strictly utilitarian approach to value measurement. It may be true that existence value is zero when it is narrowly defined to preclude all direct and indirect exposure to the animal or information about the animal, but this is conjecture. Even if we accept the conjecture, the question arises as to how, then, are nonuse values to be measured? Mendelsohn argues that these values are captured in payments for movies, television documentaries, live zoo and aquarium exhibits, and books. However, any effort to enumerate the large number of media exposures for any particular animal and then ascertain the total willingness-to-pay for that species would generally be such an enormous task as to render it an impossible endeavor. Furthermore, casual conversation with individuals concerned about wildlife protection will reveal that there are those people who adamantly claim their values are not tied to utilitarian concerns. Even if we concede that such individuals actually value animal species because of what might be defined broadly as a utilitarian concern for ecological integrity which is required for their own species' long-term survival, we would argue that the issue is one of semantics.

We define existence value as the maximum willingness-to-pay for those benefits which are not tied to direct use. By direct nonconsumptive use, we are referring to current or future onsite observation of animal species. The distinction is important because it allows individuals to indicate their demand for the public good even though current or future uses are not intended. In this way, benefit estimates for species preservation need not

be tied necessarily to recreational use. Some empirical work has shown that up to two-thirds of reported willingness-to-pay estimates for marine mammals were not tied to onsite use.

REVIEW 4

Mendelsohn's report uses willingness-to-pay as the basis for evaluating the economic value of species. However, the main issue would seem to be an evaluation of the loss that would occur if a species were to disappear. The policy trade off is how much effort should be put into preservation, or in not allowing the demise of the species. It is, then, the potential loss that would appear to be in need of assessment.

The measure of a loss is generally agreed to be the minimum compensation needed to leave people as well off as they are without the change (in this case, the loss of a species). The willingness-to-pay measure has often been used a substitute for the more appropriate compensation demanded measure, but this has been done on grounds of convenience and not on ones of better measures.

The assumption of equivalence, that justified the easy substitution of the payment measure for the compensation measure, now appears to have little or no empirical support. A fairly large number of studies have tested this and a large disparity is the common finding. The results from these studies suggest that if you were to ask people their minimum compensation needed to accept the loss, the answers are not likely to be "near zero or irrelevant" even for nonuse values.

REVIEW 5

Although Mendelsohn's report presents and discusses a number of interesting points, it does not provide a clear description of the purpose of the study or the potential utility of additional studies that might be undertaken to provide quantitative assessment or measures of the variables described therein. As an example, although the title of the report indicates that special attention was paid to the benefits of preserving humpback whales, there only are a number of references to, and no substantive discussion of, such benefits in the report.

I think that there are a number of factors which the report does not, but perhaps should, consider. As examples:

1. The Endangered Species Act, the Marine Mammal Protection Act, and other authorities, state as well as federal, reflect, in some respects the value which Congress, special interest groups, and the general public attribute to protection of marine mammals and endangered species, but this is not recognized or reflected in the report;

2. Whether a potential voter is interested and likely to vote for or against a candidate or a referendum because of attitude or possible impact on endangered species or the aforementioned types of statutes may be a

better indicator of perceived value than some of the economic indicators described in the report;

3. Extinction can result from natural processes, human activities, or combinations thereof and it would be reasonable to apply different standards to assess the possible costs and benefits of preserving species which are endangered as a result of natural processes versus man's activities, e.g., if a species or population is in danger of extinction as a result of overharvesting, a different standard arguably should be used to assess cost than for a species that is in danger of extinction because of natural environmental change; and

4. In many, if not most cases, it will be impractical or impossible to obtain reliable measures of nonuse values so that attempts to quantify the possible costs and benefits of preserving endangered species may well introduce a bias which, because of the lack of data, will tend to underestimate and devalue nonuse and nonconsumptive values.

Pages 2-3.

As noted here, there are two types of direct use--consumptive and nonconsumptive. However, there also are two types of consumptive use: (1) for subsistence purposes, and (2) for commercial or economic purposes. Thus, while it generally is true that endangered species are not suited to provide consumptive economic benefits, some, like the bowhead whale, provide important subsistence and cultural benefits.

Page 4, carryover paragraph.

The last three sentences in this paragraph state that "Except in unusual circumstances where man has mismanaged a species terribly, the forces which drove a population near to extinction also limit the species potential for consumptive use.... Most endangered species consequently will have low consumptive direct use benefits." Virtually all endangered marine mammal species and populations are endangered as a result of unregulated or poorly regulated commercial hunting. Thus, while it may be true that most endangered species have little potential for future consumptive direct use benefits, many or most marine mammals may be an exception to the general rule. In this regard, it would be helpful to indicate what is meant by the adjective "low." Does it mean, for example, that the potential future yield will be substantially less than the potential sustainable yield prior to overharvesting, or that it will be 10, 20, or more years before the species or population in question has recovered to the point where hunting might again be considered, etc.

Page 4, paragraph 2.

As noted in this paragraph, individuals clearly are willing to pay substantial fees to be able to view certain species at close range. This willingness may well be due, at least in part, to the rarity of the species and may decline if the species becomes more common.

Pages 6-7.

The paragraph beginning on the bottom of page 6 and continuing on the top of page 7 indicates that the contingent valuation approach could be used to measure the user value of humpback whales in Hawaii. Although this no doubt is true, a measure of the user value of humpback whales in Hawaii would be of little value without similar measures of the value of the whales when they are present in areas outside of Hawaii. That is, if the purpose of the valuation is to provide a basis for deciding between potential competing uses for a given area, the impact on uses and values outside, as well as inside, the area in question should be determined and considered, e.g., if impacting humpback whales in Hawaii impacts potential user value in Alaska, this should be determined and considered in the cost/benefit analyses.

Page 7, paragraph 5.

This paragraph states that "...it is an open empirical question whether or not indirect use is a sizable component of the benefits of maintaining an endangered species, and the presumption must be that they are not." The presumption is justifiable on the grounds that a species' impact upon the ecosystem of which it is a part is a function of population size and does not take account of the potential consequences or cost of being wrong. Similarly, the presumption does not appear to take account of the possible benefits from recovery, rather than maintenance, of endangered species, or steps that possibly could be taken to encourage or facilitate recovery. Available information suggests, for example, that sea otter predation on sea urchins and other herbivores enhances kelp production and that kelp production, as well as recovery of the southern sea otter population, could be expedited by establishing sea otter colonies outside their present range in California. Available information also suggests that commercial abalone and other shellfish fisheries have developed in certain areas because sea otters were hunted to extinction in the areas and that reestablishment of sea otters will eliminate commercial fisheries for certain shellfish species.

Pages 9-10, existence value.

It probably is correct to conclude that true existence value, as described in this section would be different if the concept were defined somewhat more broadly. As an example, relatively few people have the financial resources to visit remote areas, such as the Antarctic, yet many, if not most, people probably attach great value to such places because they would like to visit them and, no matter how small, the opportunity exists as long as the place exists.

Pages 10-11, bequest value.

One of the often stated objectives of conservation is to assure the greatest possible range of management options for future generations. This objective is reflected, in part, in the bequest value discussed in this section. The principal difference seems to be that the bequest value, as

described, is determined by how much an individual is willing (voluntarily) to pay to provide management options for his or her children whereas conservation, as described, includes a nonvoluntary obligation to provide such options. It is possible, therefore, that methods used to estimate bequest value do not provide a meaningful or accurate measure of bequest or obligation value.

Pages 11-12, scientific values.

Endangered species have educational as well as scientific values. As an example, in cases where species or populations are endangered as a result of man's activities, the study of the harvest practices or other factors responsible for the endangered status of the species or population can, and should be, used to determine how such consequences can be avoided in the future.

Page 12, paragraph 4.

This paragraph indicates that a cursory screening probably would be sufficient to identify species with chemical values worth keeping. This conclusion is based upon an assumption that we presently know all chemical compounds that ultimately may be of some use. The assumption probably is not valid. Consequently, the validity of the conclusion is questionable. In this same context, the cost of protecting thousands may be outweighed by the benefits derived from but one.

Page 18, paragraph 3.

The penultimate sentence in this paragraph states that: "The major conclusion of the paper is that nonuse values of endangered species are near zero and irrelevant." The conclusion may reflect difficulty in conceptualizing and measuring nonuse value, and may not be valid. Moreover, focusing empirical work upon measuring the use values of endangered plants and animals could introduce bias which will tend to undervalue these species to an extent which is neither predictable nor measurable.

Page 19, paragraph 2.

The last sentence in this paragraph indicates that: "...if the benefits of a species are in viewing rather than scientific information, tour boats should be given preference of access over scientific experimenters." This statement obviously is correct. In practice, however, it probably will be possible to determine the benefits likely to be derived from viewing, but much more difficult to determine the benefits that might be derived from research. In addition, the former will benefit relatively few people, whereas the latter can benefit many. Therefore, while true, this statement may be of little practical utility.

In summary, this paper presents and discusses a number of interesting issues. Most of the conclusions seem reasonable and conceptually sound. However, it appears to me that there is little practical utility in attempting to quantitatively assess the benefits of preserving endangered

species, except on a case-by-case basis, since there are a number of potential sources of error and bias and no way, in most cases, to accurately predict or measure the significance of the possible error or bias. Therefore, from the information provided in the report, I can see little to be gained from undertaking empirical research "in an attempt to measure the public's perception of the benefits from preserving endangered marine mammals in the western Pacific."

REVIEW 6

While Mendelsohn's paper is an interesting discussion of all the possible values, from an economist's viewpoint, that an endangered species could have, I have serious doubts that these values could be empirically measured in a meaningful way. Consequently, while such measurements might still be undertaken, to accept the value derived from such an exercise as a realistic measure of the total value of marine mammals and to use such a value as a basis for marine mammal management decisions would be a mistake.

At the outset, I object to the utilitarian perspective. The value of a species is not due only to its usefulness to man. Mendelsohn is frank to acknowledge that his paper adopts a utilitarian viewpoint, and he makes only brief mention of what he calls an alternative "altruistic" view--that a species should have a right to exist independent of any utility to man. I think this alternative viewpoint deserves more serious consideration; however, this is a basic philosophical difference about which little more can be said here. Even as measured by the benefits to man, though there are many intangible (and probably unmeasurable, though I hold open this possibility) values not captured within the types of values discussed in the paper. To see this, ask what the value of the Bible is. Could it be measured by knowing the price of all copies of the Bible sold throughout history? Could it be measured by asking people how much they would be willing to pay to keep it from going extinct? Obviously not. The point is that there are mental (inspirational, spiritual) values which can profoundly affect people's behavior, outlook, and quality of life and which are not measured in economic terms. Many people would describe the value of endangered species in terms of such intangible factors.

Even if resources like endangered species could be expressed in monetary terms, I am skeptical that they could be measured in any meaningful way. One issue is how any proposed system of measurement will weight individual differences between people in how they value endangered species. Clearly such differences may be large, but it is not clear what weighting of the differences would be best. Another issue, an important and fundamental one, concerns how future values are weighted against present ones. The economist's standard tool for dealing with this is to discount future values. I have two comments here. The first is that it does not seem appropriate to apply concepts of discounting to something like existence value, which does not grow like a biological stock or a bank account. Because the growth rate of existence value is zero, any nonzero future discounting rate will tend to make the present value of the resource seem more important than future value. In strictly economic terms, the best strategy would be to "cash in" on the present value of the resource and

invest the money elsewhere where it will generate a higher rate of return. The second comment is that any choice of a future discount rate presumes knowledge of people's future beliefs and attitudes. This is an extremely risky proposition even in the near term. To predict how people will value humpback whales 50 years from now is very difficult, to say the least. Certainly attitudes have changed dramatically in the last 50 years.

A number of arguments in the paper use the fact of a species' rarity as an argument against it. Thus, an endangered species is seen to have low scientific value or low chemical mining value because it is not abundant enough to conduct scientific experiments on it or to produce a sufficient quantity of useful chemical. This argument can lead to a vicious circle, because if a species has low scientific value, it does not need to be preserved; hence will become even rarer, hence having even lower scientific value, etc. We should separate arguments for conserving species in general, before they become rare, from those arguments for conserving species which are already rare. The fact that a species is already rare should not be used to discount its importance further.

Finally, by focusing on the value of an endangered species isolated from the ecosystem of which it forms a part, the paper misses important biological phenomena at the community level. An analogous situation in fisheries is management based on the dynamics of a single fish stock, isolated from the effects of predation and interspecific competition, as opposed to a management outlook which considers the health and stability of the whole marine ecosystem. There are whole community and ecosystem effects (e.g., global CO_2 balance) not addressed in a species-by-species approach. In addition, by analyzing single species, many types of value appear low, while in the aggregrate, they may be high. For example, if we consider a single species of plant, and ask what the probability of finding useful genetic and/or chemical material is, the answer is that it is low. But if we ask what the probability of finding useful genetic and/or chemical material is among the plants in a whole ecosystem, such as the Amazon basin, the answer is that it is certain. If we considered each species singly, we could dismiss each one, but taken as an whole, the picture is quite different. The proper focus should be the habitat or community level (for strong biological reasons also).

The net result of these comments is that I do not beleve that any method of measurement of the existence value of an endangered species could produce a number which is meaningful in an abolute sense. At most, it could produce a number useful as a relative index of the value people put on one species as against another. Even here, though, any management action based on this index of relative value would still involve the assumption that people's attitudes toward the relative importance of the two species would not change in the future.

I summarize my objections to the approach in Mendelsohn's paper by considering the field in Mexico in which Zea diploperennis, the disease resistant, perennial species of wild corn, was recently found. What value would we have put on that field before Zea diploperennis was discovered? Hasn't our idea of the value of that field greatly changed since the

discovery? Could I, as a scientist, have predicted that such useful genetic material would be found there? And if they could have been polled, what value would the starving people of the world, who are the potential beneficiaries of this discovery, have put on that remote and seemingly insignificant location in Mexico? Fortunately, the discovery of this wild corn occurred before some mangement decision based on existence valuation allowed it to become extinct.

REVIEW 7

Robert Mendelsohn's view of the benefits of endangered species is based on erroneous inferences of the empirical work on option and existence value, and his views are not representative of most of the researchers working in this area. To limit benefit estimation to direct onsite users represents a serious step backward in the evolution of environmental economics and benefit cost analysis. I would strongly suggest reviewing Stoll and Johnson's (1984) paper on whooping cranes before establishing a survey research agenda. Whereas one should certainly measure onsite, non-consumptive recreation use, as Mendelsohn has suggested, to stop there would result in serious underestimation of the economic benefits. Several other Federal agencies, most notable the Environmental Protection Agency, have embraced the concepts of option and existence values as possible components in a benefit cost analysis.

There are several literature sources that could provide a rigorous description of existence value that have not been cited by Mendelsohn (Desvousges et al. 1983; McConnell 1983; Randall and Stoll 1983). An intuitive understanding of existence value is quite easy, however.

A person may derive benefits from knowing a natural resource exists and is protected without any expectation of future use. Economic theory does not rule out the possibility that existence of something may enter a person's utility function directly as a specific argument. This notion seems hard for Mendelsohn to swallow, although Thurow (1971) made this exact point with regard to income distribution entering an individual's utility function and generating a demand for greater equality of income. His argument is that the income distribution takes on the characteristics of a pure public good in the utility function. The benefits of national defense would appear to arise as utility gained from knowing that missiles and radar are inplace without ever having seen either. Clearly existence value is also a public good in which millions of individuals can simultaneously derive satisfaction from knowing species exists. There is nothing in economic theory that requires a good to be tangible for consumers to gain utility. And yes, dishonest entreprenueurs could have taken advantage of consumers in such cases as medicines, etc., because utility can be gained from just believing that something will occur even if the consumer does not have tangible firsthand proof. Papers by McConnell and Randall-Stoll would have provided Mendelsohn with a rigorous presentation on how existence value would enter into the utility function.

In some cases, as Miller and Menz (1979) have pointed out, the level of existence value can vary with the stock of a particular species. As the

population rises, the total existence value goes up but the marginal existence value of an additional animal would likely fall, once a self-sustaining population were reached. Thus, the number of animals could enter the utility function. This argument in the utility function would provide utility from just knowledge that the population exists and from increasing the utility associated with onsite use.

Mendelsohn also ignores the evidence for existence value contained in non-game checkoff contributions. In several states, 8-14% of taxpayers receiving refunds contributed to Non-Game Checkoff Newsletter (1982). With such a large percentage of the population contributing to unusual species (such as endangered fish, lizards, and the black-footed ferret), it is unlikely all of their contribution was made solely to provide onsite recreation opportunities. The fact that millions of dollars are contributed each year to non-game checkoffs by a broad cross section of the American public certainly raises the possibility that existence value is present and could be substantial.

The following reflect specific comments on Mendelsohn's misinterpretations of empirical work and on benefits of secondary use:

1. Page 5, paragraph 2. The statement that the three techniques are hedonic travel cost, market demand, and contingent valuation is probably misleading to anyone not familiar with the literature. Hedonic travel cost is a special variant of the basic travel cost method. While Mendelsohn has made a contribution with his hedonic travel cost method, the basic travel cost method was developed in 1959 and had been modified to include site characteristics as demand shifters in 1976.

2. Page 8, discussion on secondary use. While I strongly support Mendelsohn's notion that what wildlife contributes is the net contribution over and above the other costs of the book or movie, he misses an important point in this section of his paper. He is too worried that we will double count the professional photographer or writer or that the main benefit of movies or books is that it stimulates future onsite use. Mendelsohn seems to ignore the benefits to people from the enjoyment of the book or movie itself. The "audience" for the book or movie receives a consumer surplus as well. Specifically, the net willingness-to-pay of the "audience" is their additional willingness-to-pay for viewing this movie or reading this book or magazine with this particular wildlife species as compared to the next best alternative movie, book, or magazine. His example of Ansel Adams and his conclusion of the third paragraph are very hard to support without some evidence. The large number of posters depicting scenes from our national parks are testimony that the secondary benefits are large to the intended audience (if not to the photographer as well).

3. Page 10. Mendelsohn's discussion of the Walsh et al. (1984) wilderness paper is in error. The article referenced stated that the respondent was asked "...allocate the highest amount reported among the four categories of value: recreation use, option, existence and bequest demands." (Walsh et al. 1984: p. 17). Since there were spaces on the questionnaire for recording benefits of recreation use this year and the

option to maintain possibility for future visitation, why would anyone put onsite recreation benefits into the existence category? Had Mendelsohn looked at the complete survey, he would have seen the following preface to the existence value space: "Payment to preserve wilderness areas for reasons other than your own personal use." Thus, consumers, were told that the percentage going in that space was not related to personal use which would include not visiting the site. Even more explicit wording can be found in Stoll and Johnson's questionnaire on whooping cranes.

I feel that Mendelsohn should rethink his conclusions about existence value based on this clarification to the Walsh et al. (1984) survey's existence value question and the work of Stoll and Johnson.

4. Pages 14 and 15, discussion of option value, represents either a careless reading of Walsh et al. (1984) or a very skeptical mind. The point about separating the expected value of future recreation use is dealt with extensively in that article. An empirical "proof" showed that expected consumer surplus was $75 and the measure of option value was $9 (both per year figures). In addition, a comparison of option value wording is dis-played which indicates that option value, not option price, was what is measured.

Mendelsohn also has a very different discussion of the relationship of option price and option value. The option price of a park is not usually regarded as the person's tax payment for it but rather as the sum of expected consumer surplus and option value premium. It is usually assumed that respondents calculate the expected consumer surplus and then determine if they are willing to pay anything beyond that. The tax payment is not the option price but the individual's cost of the project. Failure to see this leads Mendelsohn to make the statement that "If consumer surplus exceeds option price the public conservation projects should be assigned a risk premium cost." If the consumer surplus exceeds the tax payment, then this is added benefits and not a cost. The consumer surplus is actually larger than the recreationist initially expected.

REVIEW 8

I see little with which to disagree in either the way Mendelsohn has approached the topic or in most of the detail in his arguments. I agree with his recognition of two kinds of perspectives in evaluating the benefits of assuring the continuing existence of an endangered species, and with his conclusion that the first of these perspectives, the "utilitarian" one, may generally be given the greater weight in public policy determination. However, I would argue that the full weight that should appropriately be given to the second perspective, at least in our society, is not implied by the title he uses for it, "altruistic," or the definition he provides for it (page 1, paragraph 1). I will present my bases for this argument later in this letter.

Mendelsohn defines his second, "altruistic" perception concerning the saving of an endangered species on a possible right of every species to its perpetuation (page 1, paragraph 1). I would claim:

1. That whether species have "rights" to perpetuation is a matter of personal philosophical religious belief;

2. According to evolutionary theory backed up by ample paleontological evidence, innumerable species once existing have ceased to exist;

3. If there were in a species an inherent right to exist, that right would be one granted by man not by nature;

4. In granting a species a right to perpetuation, man would be putting himself in the position of being responsible for defending that right against other species and against the inanimate forces of nature. I believe this would be both hubristic and quite impractical;

5. History provides evidence: a) that the human race has not only failed to grant existence rights to species generally, but has caused the extinction of species; b) that although the extinction has, in most cases, been careless, deliberate attempts have been made to extinguish some species; and c) that there is perhaps one case in which a deliberate attempt at extinction in nature has been successful.

The efforts to extinguish mosquito species serving as vectors of human disease are examples in support of claim 5b. Whether claim 5c is valid depends mainly on the semantic question whether the smallpox virus is a species or not. There seems now to be no question that, as the result of deliberate, worldwide, public health policy and practice, the smallpox virus has been rendered extinct in nature, and preserved only in frozen state in the laboratory. (Its preservation in this state has a demonstrable utilitarian, nonaltruistic motive.)

As indicated earlier, I believe there is a valid alternative second perspective. However, this perspective, like the first is, in my opinion, based on the values to humans of continuing the existence of species. It differs from the first only to the extent that, whereas the values in the "utilitarian" perspective are essentially tangible, those in the second perspective, which I will refer to simply as nonutilitarian (as Mendelsohn does on page 17) are essentially intangible, although they may be expressed in tangible ways. Aesthetic values and ethical values are pertinent examples.

That aesthetic values may be tangibly expressible, and in some cases substantial, may be indicated by referring to the enormous sums that individuals and museums are willing to pay for certain paintings. That they are officially regarded as real may be indicated by referring to their treatment by the Internal Revenue Service. It is important to note that the aesthetic values of paintings, although not utilitarian, are nonetheless attributed to the paintings by people, and not inherent in the canvas and paint of which the paintings are composed. It seems to me unquestionable that aesthetic values are attributed by people to both inanimate natural features, such as waterfalls, and to creatures and to species of creatures, such as beautiful birds or birds that have beautiful songs. These values may be estimated in terms of the prices people are willing to

pay to preserve the aesthetic qualities. The evaluation methodologies are essentially the same as some Mendelsohn refers to in the evaluation of recreational values (utilitarian), "existence" values (whether partly potential-use or not), "bequest" values (whether potential-use or not), etc. I get the sense that Mendelsohn is skeptical as to the significance of the results of such analyses. It must be recognized at least that different people would attribute very different values to the same feature or creature or species. When, however, a value has been attributed through the political process to a feature, creature, or species, in the establishment and funding of a program to save it, there can be no doubt about the official reality of the value. I would think it quite inappropriate for a public agency to assume that no aesthetic value attached to the saving of feature, creature, or species, and to fail to put some tentative value to the test of public acceptance.

Most of my comments regarding aesthetic values apply to ethical values as well, but I wish to discuss in addition how the attribution of an ethical value to an endangered species differs from the assumption of a right to its persistence.

No one has demonstrated that humpback whales, for example, no matter how intelligent, have perceived that they have a right to the perpetuation of their species. Except as a matter of faith, then, the perception of such a right is human. Such a perception is ethical (philosophic and/or religious). In a nation with an official religion, it may be appropriate to transfer the concept of a right to species perpetuation from religious doctrine to law and official policy. In a democracy such as ours, however, although the religious beliefs of the majority may well be reflected in law and public policy; religious doctrine in itself cannot be accepted as the basis for law or public policy.

I can perhaps elucidate the matter by reference to personal opinion. I do not believe the humpback whales perceive a right to the persistence of their species nor even perceive the threat to their species. I could not rationally grant to any species (other than the human species) an inherent right to its perpetuation in the light of my opinion concerning the smallpox virus and the anopheles mosquitoes. However, I would attach a high value to official actions to perpetuate the humpback whales, even if their perpetuation had no utilitarian value, simply because I like the whales. From ethical, philosophic, and religous beliefs, I derive a desire to avoid being a party to killing them off, and I would vote in favor of public actions to save the whales in the hope that the majority would vote with me.

To summarize the thrust of my argument, it is that it is inappropriate in a society such as ours to base the nonutilitarian part of the rationale for assuring the perpetuation of the humpback whales or any other species on an assumed right of perpetuation, but that the nonutilitarian part of the rationale may be based appropriately, and with greater force, on aesthetic and ethical values attributed to the species by the majority of the society.

REVIEW 9

1. Mendelsohn's report suffers from a fuzzy definition of categories (Table 1). "Mining" for chemicals and genes is certainly "direct" and likely consumptive, as are most "experiments." The organization of categories seems upside down; "consumptive" and "nonconsumptive" higher-level categories and "recreation" and "nonrecreation" should be lower-level. In any case, Table 1 does not follow the organization of categories on page 1; this is very confusing to the reader.

2. Pages 3-4. The argument about the low consumptive value of endangered species is overly simplistic and ignores the interactions of direct uses and socioeconomic factors. For example, the bowhead whale is endangered. It may be possible, however, that the present limited take by United States and Canadian Inuit is not further endangering the species or preventing growth of the population. Preservation of the Inuit (Eskimo) culture and way of life has high value in the United States in terms of humanist ethics and political clout. So a rather small cash value of consumptive use translates into a rather large value in the social perspective. One must also account for the earnings of the Inuit lobbyists, the anthropologists and whale scientists who study the bowhead whale fishery, etc. Similar situations exist for other endangered cetaceans, e.g., the sperm whale in Japanese waters.

Another way that considerable monetary value can accrue to consumptive use of small numbers of animals is in the exhibition industry. A rare animal on display at an oceanarium or zoo (for example, the gray whale held for a year at Sea World, San Diego, and the monk seals at Waikiki Aquarium) can increase gate receipts significantly. Another example is that of the sea otter, which is the only marine mammal on display at the new Monterey Aquarium, which is expected to have millions of paid visitors over the next few years. If someone figures out how to catch a sperm whale and keep it in captivity, it could be worth millions. Although the San Diego gray whale was released, most capture for exhibit is consumptive.

Yet another example of potential high-value consumptive use of only a few animals is that of "mining" for genetic material. A gene from a single individual could have very high monetary value when incorporated into an organism used in agriculture, manufacturing, or medicine.

3. Page 5, paragraph 1. I understand the point he is making here and agree to some extent, but the parallel drawn between near-identical grass species and marine animals is not a good one. In primitive societies (hunter-gatherer), every species of animal in the tribal range has a name known by everyone and would be missed immediately were it to disappear. In civilized societies (pastoral, agrarian, and urban), the knowledge of the existence of animal species is a function of education. One hears and reads of "the whale" and "the dolphin," but a modicum of education changes that quickly, mainly because of the high degree of morphological diversity of marine mammals. Even experts can confuse some species, such as sei and bryde whales or California sea lions and northern sea lions, but these species pairs usually occupy largely different ranges with only some overlap

and are the exception. Thus, what "fraction of the taxonomist's species truly qualify as unique" in our society is a variable correlated with education, and any model or scenario must have a dynamic element to account for this, especially with the current high level of public interest in and awareness of marine ammals.

4. The section on analysis of whale-watching (pages 5-7) seems good. This is probably the main thing you need anyway.

5. Page 7. Seals don't eat abalone; sea otters do.

6. Page 7. An example that runs counter to the conclusion in the last paragraph is that of the sea otter. In the parts of the range in which the species has been extirpated, sea urchins have increased to the point of limiting growth of kelp forests that are the basis of a multi-million dollar industry. Urchins are now partially controlled at great expense by divers with hammers and chemicals, but only very few otters in a local area would probably suffice to control them, as they do in their present range, (mainly because of an extremely high metabolic rate; they have no blubber insulation like seals have, but only fur). On the other hand, the very valuable abalone fishery in southern California possibly could not coexist with a sizeable otter population.

7. Page 8. The section on secondary use makes very good points about the valuation of books, films etc., that have not been considered in past treatments of this, e.g., by Payne in the 1976 Bergen Consultation (ACMRR, FAO), in the Whales Alive conference, and elsewhere.

8. Page 10. The "casual empirical evidence (suggesting) that their existence value is zero" is just that. In the absence of appropriate surveys and analyses, his conclusion is cavalier in the extreme and would seem to reflect a personal subjective opinion rather than careful and objective consideration.

9. Pages 12-13. The section on "chemical mining" is weak. The suggestion that a "cursory screening" of wild species would show a "low expected value for chemical mining" ignores the time axis of knowledge and technology. One cannot look for something if one does not know what it is or what it does. Repeatedly, there have been quantum jumps in knowledge that have prompted new searches and new awareness of potential value (the rediscovery of Mendel's work, the discovery of antibiotics, the recent advent of genetic engineering, etc., etc.) The wild plants and animals are a storehouse of genes and substances that we will revisit again and again, each time with new perspectives on what we're seeking.

Of course we have to be more careful in examining endangered species in such searches, but that does not lead logically to the conclusion that endangered species would be further endangered and therefore, are not of potential value in this regard.

10. Pages 13-14. The conclusion that "quasi-option value only applies to species which are of current research interest" presupposes that whatever

is of current research interest gets investigated. Because of the vagaries of politics, budgeting, scientific fads, and the geographical distribution of scientists and money, etc., there are certainly many situations where more information is of present value but is not collected. Thus, the local bureaucrat making the decision to destroy a species or habitat may not be aware of its potential value even though a scientist or a corporation on the other side of the continent or world would immediately recognize its value were its existence known. In the lack of universal knowledge, the decision maker must assume that a species does embody information of value and balance that unknown value against other considerations, keeping in mind that there may well be a better basis for a decision in the near future. Or maybe this is "option value." The definition and usage of that term (pages 14-17) is certainly confused, and I don't see how the author got to his assertive conclusion in the last paragraph.

11. Page 17. The section on "nonutilitarian benefits" is a flyer in philosophical ethics apparently based on the idea that we are only a dominant animal among other animals, whereas the issue has been raised by those who believe that because of our higher sensibility (the human condition), we have the capacity and therefore, the obligation to be altruistic, as an expression of the will of the deity that we embody, i.e., as an extension of the Judeo-Christian ethics. I think that the author is out of his depth here, basically attempting to discuss a religious issue in a scientific essay. It's probably enough to say just that some people believe in cross-species altruism and can be expected to attempt to influence decisions affecting species and habitats. I don't know how you'd quantify it; perhaps, by the amount of money spent in such lobbying.

REVIEW 10

I found Mendelsohn's paper a very interesting compendium of methods for measuring benefit or value, applied in this case to endangered species. I do not agree with all of the logic or conclusions, and some of the economic jargon went over my head. Specific comments follow.

Page 1. A small point, but isn't the paper concerned about measuring the benefits of endangered species in quantitiative terms useful for making decisions about their preservation? In many places, Mendelsohn discusses the logical underpinnings of a valuation method, but does not say how to measure it.

Page 2, bottom. This paragraph seems out of place. It also does not lead the reader anywhere--I guess the conclusion is that existence per se does not allow us a means of quantifying benefit for decision making purposes.

Page 5. A minor but confusing point, fish and fisheries (man's catching of fish) are mixed up in the text.

Page 9, Indirect Use. There is no discussion of how to quantitatively measure indirect use.

Pages 11-12 and also page 13, top. Wouldn't capturing an author/photographer/etc., by use of a survey for direct use measurement be a rare event and therefore, be expensive and difficult to do? Wouldn't it then be better to measure the secondary use?

Page 15, top. I do not think he has substantiated his conclusion. For example, I have no future plans for "direct use" of the desert pupfish, have no plans to visit the spring where it lives, am not even sure of the location of the spring, except that it is somewhere in the southwest, but I feel that it should be preserved because it is such an unique animal.

Pages 16 and 18. The trouble I have with both of these sections is that I do not know of a way of deciding today what scientific or chemical benefit an organism may have in the future. We may have a set of needs or uses by today's standards that we could use to screen organisms for potential uses, but what about tomorrow's uses? Thus, I disagree with his conclusion that there is no measureable benefit for these uses, but I do not have the slightest idea of how to measure such benefit.

REVIEW 11

Mendelsohn has prepared an interesting and provocative review of the issue. As you probably are aware, Brown and Mendelsohn elsewhere have developed the hedonic travel cost method. This approach represents an important contribution to the procedures available for estimating the recreation use value of environmental quality. Unfortunately, Mendelsohn appears to exaggerate its potential contribution and distort other legitimate methods. Thus, the paper appears to be self-serving rather than a scholarly assessment of the procedures to estimate the existence values for marine mammal resources.

The author misrepresents the procedures and findings of Walsh et al. (1984) of water quality and wilderness areas. For example, he is in error at page 10 where he states that existence value is limited to individuals who have never visited the site. Users were asked to report their payment to preserve wilderness areas and water quality for reasons other than their own personal use. Mendelsohn errs in stating that: "It is highly likely that most, and possibly all, of the measured existence values are merely capturing a component of use value..."

At page 11, he ignores the fact that individuals report that they are willing to pay each year for the satisfaction derived from bequest value of the resource to future generations. This is not present value of future recreation use value as Mendelsohn alleges, but rather the annual benefits of knowing that future generations will have the resource available.

At page 15, he errs in reporting that Walsh et al. did not separate option value from the expected value of consumer surplus of recreation use. Respondents were specifically asked to make this allocation and it was found that option value varies from zero to small, to large, for different individuals and that expressed on a per capita basis is important and should not be ignored at the risk of biasing decision. It represents the

annual benefit of knowing that the resource will be available should they decide to use it.

I applaud his suggestion that movies, books, TV, and related offsite use value be measured by the hedonic approach. This contributes to total existence value, but does not represent a complete measure. Still, partial measures are useful.

It should be acknowledged that concepts of nonuse value are not fully developed. For this reason, we should be more gracious and tentative in our treatment of the ideas of others. In the end, they may prove as realistic as our own.

LITERATURE CITED BY REVIEWERS

Cooter, R., and P. Rappoport.
1984. Were the orginalists wrong about welfare economics? J. Econ. Lit. 22(2):507-530.

Desvousges, W. K., V. K. Smith, and M. P. McGivney.
1983. A comparison of alternative approaches for estimating recreation and related benefits of water quality improvements. EPA Contract No. 68-01-5838. Prepared for Econ. Anal. Div., EPA, Wash., DC 20460.

Huppert, D. H.
1983. NMFS guidelines on economic evaluation of marine recreational fishing. NOAA Tech. Memo. NMFS, NOAA-TM-NMFS-SWFC-32, 35 p.

Kahneman, D., and A. Tuersky.
1979. Prospect theory: An analysis of decision order risk. Econmetrica 49, 263.

Knetsch, J. L.
1983. Property rights and compensation - compulsory acquisition and other losses. Butterworth and Co., Seattle.

McConnell, K. E.
1983. Existence and bequest value. In R. Rowe and L. Chesnut (editors), Managing air quality and scenic resources at national parks and wilderness areas. Westview Press, Boulder, Colo.

Meyer, P. A.
1979. Publically vested values for fish and wildlife: Criteria in economic welfare and interface with the law. Land Economics, 223 p.

Miller, J., and F. Menz.
1979. Some economic considerations for wildlife protection. South. Econ. J. 45:718-729.

Non-Game Checkoff Newsletter.
1982. Check-offs raise $3.3 million. Non-Game Checkoff Newsl. 2(1), Fall.

Randall, A., and J. Stoll.
1983. Existence value in a total valuation framework. In R. Rowe and L. Chesnut (editors), Managing air quality and scenic resources at national parks and wilderness areas. Westview Press, Boulder, Colo.

Schulze, W. D., R. C. d'Arge, and D. S. Brookshire.
1981. Valuing environmental commodities: Some recent experiments. Land Econ. 57:151-172.

Stoll, J., and L. A. Johnson.
1984. Concepts of value, non-market valuation and the base of the whooping crane. Tex. Agric. Exp. Stn. Tech. Rep. No. 19360.

Thurow, L.
1971. The income distribution as a pure public good. Q. J. Econ. 85:327-336.

Walsh, R., J. Loomis, and R. Gillman.
1984. Valuing option, existence and bequest demands for wilderness. Land Econ. 60:14-29.

Willig, R. D.
1976. Consumer's surplus without apology. Am. Econ. Rev. 66(4):589-597.

Southwest Fisheries Center Administrative Report H-84-14

THE BENEFITS OF PRESERVING ENDANGERED SPECIES:

WITH SPECIAL ATTENTION TO THE HUMPBACK WHALE

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SEPTEMBER 1984

[NOT FOR PUBLICATION]

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PREFACE

This report was prepared by Dr. Robert O. Mendelsohn during a month's fellowship at the Southwest Fisheries Center Honolulu Laboratory. The terms of the fellowship were to provide a University faculty member with the freedom to explore the nature of "existence values for marine mammal resources." In particular, we were looking for an analytical review of the economic literature on existence valuation and a conceptual discussion of evaluating or measuring the nonmarket value of endangered species such as the humpback whale or the Hawaiian monk seal.

Mendelsohn's work emphasizes the difficulty in separating nonuse aspects of a species' value from its direct and indirect use values. Mendelsohn takes a critical approach to most attempts to measure existence values for endangered species and natural resources. He further argues that measurement of use value must be sensitive to caveats concerning the type of use envisaged. Mendelsohn also takes a critical view toward non-utilitarian conceptions of value as applied to endangered species.

I believe this report provides the basis for developing more rigorous criteria for evaluating the possibility of measuring the benefits for preserving endangered marine mammals. Although quantitative comparison of dollar values in terms of costs and benefits from protection programs is not the only yardstick for evaluating preservation programs, it provides useful information for the public, user groups, and decision makers. A number of areas for practical application of the criteria suggested by this report exists within the field of marine mammal protection. A number of economists within the National Marine Fisheries Service look forward to further research in this area.

The Southwest Fisheries Center's economics fellowship program emphasizes the academic freedom of its participating scholars. As such, the report has received minimal editing although Dr. Mendelsohn did recieve written comments from Center reviewers which he was free to incorporate or reject as he saw fit. Because the report was prepared by an independent faculty fellow, its statements, findings, conclusions, and recommendations are those of Dr. Mendelsohn and do not necessarily reflect the view of the National Marine Fisheries Service.

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ABSTRACT

This paper reviews and critiques the various benefits allegedly generated by endangered species. Although total benefits may be substantial, many of these separate benefits appear to be redundant and some are probably near zero. The most significant benefit of endangered species appears to be nonconsumptive use. Several suggestions are given about how to empirically measure the benefits of endangered marine mammals in the Hawaiian Islands.

INTRODUCTION

This paper is concerned with measuring the benefits of endangered species in general and the humpback whale and monk seal in particular. Although there are virtually no quantitative estimates of the value of any species anywhere (with the possible exception of the whooping crane--see Stoll and Johnson 1984), economists have pondered the potential value of endangered species for about two decades. The benefits of preserving endangered species fall into one of two categories. The most prevalent source arises from a utilitarian perspective--the species may be helpful to man either directly or indirectly. The alternative perspective considers a more altruistic view--that all species should be given the right to exist independently of any usefulness to man himself.

There are many potential ways a species could be beneficial to mankind. (1) There is user value from direct interactions between man and the species. Whether for consumptive activities such as fishing and hunting or nonconsumptive uses such as birdwatching, hiking, or photography, man clearly obtains pleasure, enjoys, and would therefore be willing to pay for close contact with individual species. (2) In addition to direct use, it is possible there are several indirect mechanisms through which the species is helpful to man. For example, the species may control a pest or may be an important link in the food chain for another species man considers valuable. (3) The species may also provide secondary benefits through a communication medium. A wildlife movie, book, or lecture can become a link between the resource and the public. Even without direct contact, the public through this medium can enjoy the species. (4) Some economists argue that some individuals obtain pleasure just from the existence of the species. (5) Other economists argue people obtain pleasure from the knowledge that species will be preserved for future generations--a bequest value. (6) Many naturalists argue that endangered species have scientific value as potential sources of new information about genetics, medicine, and ecosystems.

The considerable uncertainty about the long-term benefits of a species coupled with the irreversibility of extinction has led to yet other values. (7) Wild species have long been a source of genetic and chemical material. A potential value of any species is consequently chemical mining--the extraction of rare biochemicals directly from the plant or animal. (8) Quasi-option value is the benefit of waiting to make an irreversible decision until more information is available. One reason to preserve species is that their destruction is irreversible and may quickly be regretted. (9) Option value has been labeled as the premium people are willing to pay to keep the chance of having a species maintained given there is uncertainty. Each of these nine potential utilitarian values will be discussed in more detail in the forthcoming sections.

Each of the utilitarian benefits can be discussed in terms of annual benefits. If the species survives, it produces a stream of annual benefits from now far into the future. The total value of this stream is the present discounted value of all future benefits. Because this intertemporal evaluation is consistent across all measures (with the possible

exception of quasi-option value and bequest value), the intertemporal quality of most of the benefits is ignored in the following discussions.

Some individuals question whether it is appropriate to judge the value of a species in terms of its usefulness to man. For example, Stone (1972) argues that perhaps nature should be given certain rights of existence. Alternatively, one could extend Rawls' (1971) discussion of income distribution across man to all of nature. Suppose we did not know which of the 30,000 vertebrate species we would be born into (the veil of ignorance), and we were asked how many species should be preserved. If we wanted to minimize our worst outcome (extinction), we would vote to keep all species. Existence would then be an inalienable right which could not be purchased away.

In the remainder of the paper, I argue that direct and indirect use are the principal reasons to maintain an endangered species. The remaining values either are reflections of direct use, and so are already captured (measured), or are too small to be of any consequence. I further argue that although one could endow each species with an inalienable right to exist, a sound philosophical argument can be made for considering the benefits and costs of each species' existence. Since the benefits of keeping a species will rarely be infinite, measurement of these benefits could be quite helpful for making better decisions about how best to allocate our preservation efforts across species.

For organizational convenience, a section is devoted to each of the nine utilitarian sources of benefits arranged in Table 1. Another section is devoted to the philosophical foundation of the right to exist. For each source of benefits, the empirical and theoretical literature on the subject is critically reviewed and preferred methods of measurement for the humpback whale and monk seal are suggested when appropriate.

It should be understood that the focus of this analysis is on the benefits of preserving individual species with dangerously low populations. Although the benefits of protecting wild populations which are not endangered are related to the benefits discussed here, some of the arguments and thus conclusions do not apply to abundant populations.

DIRECT USE

Direct use is the least controversial and most easily measured value of wildlife. There are two types of direct use--consumptive and nonconsumptive. In general, hunting, trapping, and fishing would be consumptive uses of wildlife because the participants use up the resource through their activity. Hiking, birdwatching, whale watching, and photography, in contrast, are generally nonconsumptive uses because the interaction need not harm or reduce the target population. In practice of course, these distinctions may haze as fishermen could release their catch while photographers so harass an animal that it perishes. These fine points aside, there is an important distinction between consumptive and nonconsumptive benefits. For species which are few in number, consumptive use could quickly

Table 1.--Preservation benefits of endangered species.

Use values
Recreation
Direct
Consumptive
Nonconsumptive
Secondary
Bequest
Nonrecreation
Mining
Chemicals
Genetic material
Experiments
Medical
Ecological
Biological
Nonuse values
Indirect
Elimination of pests
Enhancement of desired species
Risk
Option value
Quasi-option value
Existence

lead to extinction as the population falls below a critical minimum (Bachmura 1971). Thus, endangered species are not suited to provide current consumptive benefits. More likely, the potential consumptive benefits of an endangered species are the discounted values of consuming the species sometime in the future when its population is at a healthy number. Thus, many species who have always had a limited habitat (population), or whose habitat has been acquired by other users, will have no consumptive direct use because they will probably never have a sufficiently large population

to support taking. The Hawaiian monk seal, for example, limited to a few remote uninhabited islands of the Northwestern Hawaiian Islands, would likely fall in this category. In contrast, the humpback whale if it can recover like the sperm and gray whales have, may indeed provide consumptive use again in the future. Except in unusual circumstances where man has mismanaged a species terribly, the forces which drove a population near to extinction also limit the species potential for consumptive use. Thus, the humpback whale may sometime be hunted again, but because of its low reproductive rate such hunting could not be widespread. Most endangered species consequently will have low consumptive direct use benefits.

Several authors have discussed the conditions where upon an unregulated renewable resource could be driven to extinction. Unfortunately with common property resources such as a fishery, users tend to undervalue the common resource. Instead of maintaining the resource wisely over time, the common access users acting on individual but not communal interest deplete the stock. If unregulated, the fisheries tend to be driven to a point where minimal harvestable resources remain. Depending upon the cost of harvesting small populations, the fishery can be driven to extinction (Clark 1973; Cropper et al. 1979; Sinn 1982). Another extension of this renewable resource literature includes a discussion of how preservation value could enter the standard fishing model. Plourde (1975), Miller (1978, 1981), Miller and Menz (1979), and Porter (1982) model preservation value as being a value of the stock itself. The larger the value of the stock, the greater is the difference between the private returns to harvest and the social return. Although this literature is not directly pertinent to measuring preservation value, it does demonstrate that market mechanisms may lead to extinction even when preservation values are high enough to justify keeping the species alive.

In contrast, small populations of animals at least potentially could support relatively high quantities of nonconsumptive use. Thousands of people aboard large cruise vessels get the pleasure of viewing whales in Glacier Bay when there may be only a few whales in the whole area. A similar phenomenon with smaller tourist boats occurs off the coasts of Maui, Hawaii, and California. Clearly individuals are willing to pay substantial fees just to be able to view the animals at closer range.

The activities of naturalists who spend a large fraction of their time as volunteers or lower paid professionals observing wildlife is another example of nonconsumptive use. Clearly, these individuals are receiving substantial pleasure from their intimate contact with endangered species. Given the sizable expense and inconvenience endured by these dedicated researchers, the value of the species just to these individuals alone is clearly substantial.

Which species are likely to have large direct use benefits? Are all species of equal value? Although empirical evidence on this issue is limited, the answer is probably no--people distinctly value some species more than others. The eagle, elk, and whale are of distinct value because of their size, complexity, and grace. They are also of great value because they are distinct from other species in ways of interest to man.

The taxonomist's definition of a species is any distinct group which does not interbreed with another group. The taxonomist's observed distinctions across groups, however, may often not be shared by users. Thus, for example, there may be 15 species of wild grass with subtly different characteristics. The destruction of 5 of these 15 grasses may go unobserved to most people. On the other hand, the demise of the bald eagle or humpback whale would be a great loss to many users. Uniqueness is not an all or nothing attribute. Every species by definition is different, but they are not necessarily different in important ways. Users probably care about very unique species but their definition of uniqueness is much broader than the taxonomist's. Only a fraction of the taxonomist's species truly qualify as unique. What is relevant--seals in Hawaii, Hawaiian monk seals, or all seals of a particular type regardless of location?

Three techniques have been used to value recreational direct use: the hedonic travel cost, market demand, and the contingent valuation method. The hedonic travel cost method (Brown and Mendelsohn in press) learns from the choices users make about which sites to visit, i.e., the value they place on the characteristics of sites. Thus, if there were a series of boat trips one could take on which some saw whales and some did not, it would be possible to estimate the individual value of the whales as one of the trip's characteristics. Unfortunately, for humpback whales in Hawaii, the limited choices of destinations in which to encounter the whales would make it difficult to separate the value of the whales from other characteristics of these areas.

Because a great deal of whale watching is done on private boats which charge fees, it is possible to use a market demand approach to estimate the user value of the whales. The marginal whale watching trip is presumably worth the fee the user pays for the last trip (otherwise it would not be the last trip). However, each trip also requires substantial resources in boat capital, fuel, and labor (crew). Assuming whale watching trips are generated competitively, the marginal cost of these services is the price paid for the last trip. Thus, the last trip provides zero net benefits (the benefits equal the cost of access). The value of the whales lies in the value of the inframarginal trips (the trips before the last trip). It is, therefore, necessary to estimate the demand for whale trips. This demand function can only be revealed if there is observed price variation leaving one of two possibilities of attack: a cross-section study across operators or a time series analysis. The relationship of interest in either case is how the number of whale watching trips (person trips) is affected by the price per person trip. The consumer surplus, the area under this demand curve but over the current market price, P_0 would reflect the annual nonconsumptive use value of the resource (Fig. 1).

A third possible approach to measuring direct nonconsumptive use is to ask users what they are willing to pay to obtain access to the whale. The accuracy of the response depends upon the quality of the question because it is necessary that the respondent understand the hypothetical question being posed. Stoll and Johnson (1984) have applied this technique in Texas to value whooping cranes at Aransas National Wildlife Refuge. They found visitors (i.e., users) were willing to pay $4.47 per year to visit the

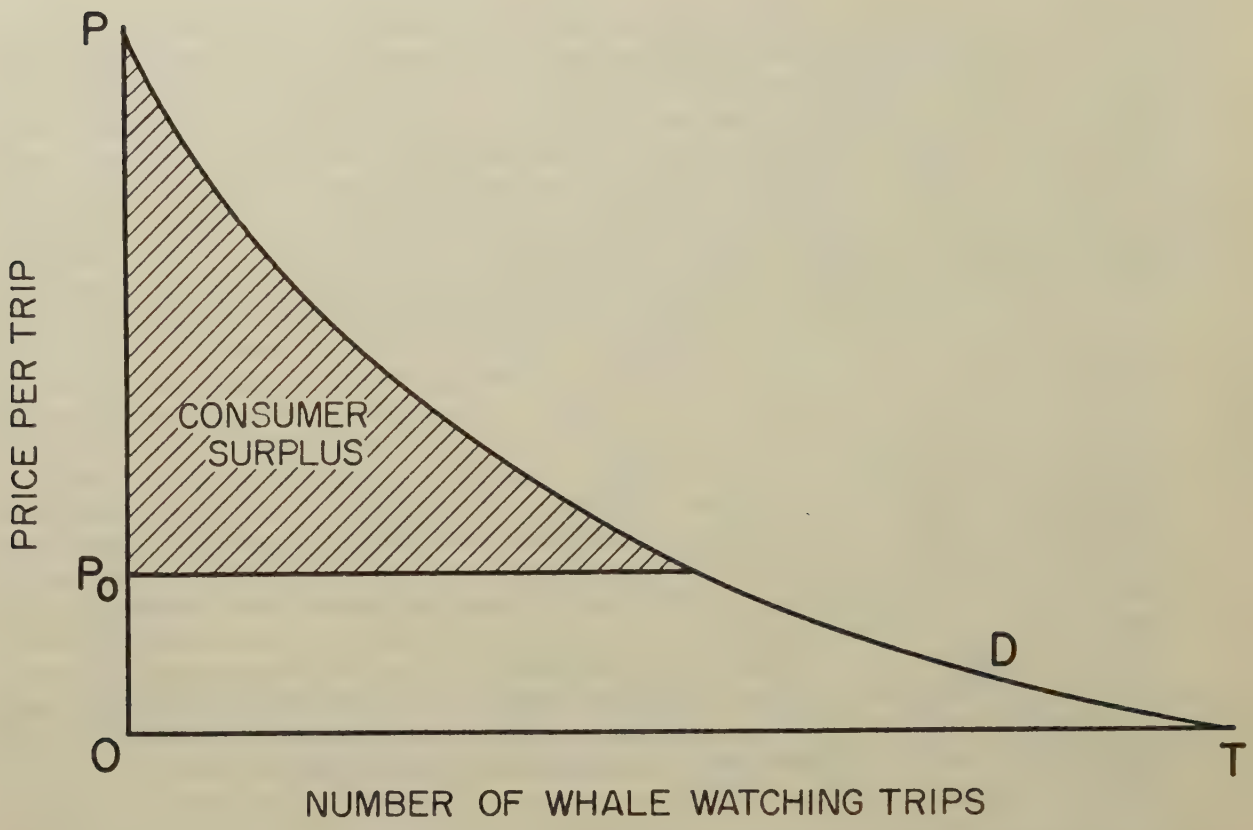

Figure 1.--The demand for whale watching trips.

refuge with whooping cranes present but only $3.07 without whooping cranes. The difference, $1.40, is presumably the value of the rare bird. Given the sample size, this difference is statistically significant at the 5% level. Multiplying by the 60,000-100,000 people per year who visit the refuge suggests the whooping crane provides $84,000-$140,000 annual benefits to Aransas National Wildlife Refuge users alone. Given the migratory nature of the bird, the total value to all "users" including people in other locations is presumably an even larger number.

Clearly the contingent valuation approach to measuring user value could be applied to value endangered species in the Hawaiian Islands. For example, all visitors to Maui and especially those purchasing the whale watching trips could be sampled to evaluate the humpback whale. In particular, it would be interesting to know what people would be willing to pay for an increased probability of seeing a whale, how much more they would pay to see the whale closer, and how much more they might pay to see more than one whale. Given that few visitors have seen a whale before, it might also be interesting to test whether their attitudes before sightings were similar to their responses after experiencing the whale. Finally, it

might be interesting to query whether they perceived that the whale was threatened or harassed by their own approach, and if it was in fact being harmed whether they would prefer such access eliminated.

INDIRECT USE

It is entirely possible that in addition to the direct value of contact between man and a particular animal, the animal provides additional benefits (or costs) through its impact on the ecosystem. For example, seals may eat abalone or lobsters and thereby reduce the population of this desired delicacy. In this case, the seal would be generating an indirect cost measured through another species. On the other side of the ledger, an animal may control a pest. For example, mosquitofish, Gambusia, catch mosquito larvae and control that pest effectively in local areas. Alternatively, fish may be an important source of food for valuable wild or game animals higher in the food chain.

Indirect use captures the relevance of the species to an ecosystem. Because ecosystems involve complex, interrelated balances, the elimination of a species can affect the remaining populations. Indirect use is consequently an important component of the total benefits of many species.

The question we must face, however, is not whether indirect use could ever be important, but rather whether it is likely to be an important component of endangered species. By definition, endangered species populations are few in number and so generally are unable to have a significant impact on the environment. For example, whether or not a population of a hundred small fishes were wiped out is unlikely to have a detectable effect on the higher food chain since such a small source of food is irrelevant to its predators. Similarly, one would think that small populations of predators are unlikely to have any effect on a prey of sufficient population to be a nuisance to man.

This reasoning, however, does have counter examples. A rare moth, Cactoblastis, tends to control the beavertail, Opuntia cactus, in places where the cactus grows naturally. Thus, when the cactus was introduced moth-free to Australia, it promptly overgrew valuable grazing lands. The moth, then introduced into Australia temporarily grew to large populations until the cactus once again was rare. With its food source reduced, the moth then became rare as well. The predator-prey cycle is such that even small populations of predators can check a potential prey pest problem. Critical to this example, of course, is the ability of the rare species to multiply quickly when the pest (food source) reappears.

Although the moth may qualify in this regard, most endangered species are probably incapable of such a rapid recovery of numbers. Thus, it is an open empirical question whether or not indirect use is a sizable component of the benefits of maintaining an endangered species, and the presumption must be that they are not. This is particularly true since most noted endangered species are just below man in the food chain.

SECONDARY USE

It is clear from the market for nature photography, naturalist lectures, and books about nature that people need not directly interact with a site to get value from its existence. Many end users obtain benefits from nature through an intermediary who has gone to the site and converted this experience into an intermediate product: a book, movie, or lecture. There is no question but that the intermediate product has value. One could add up all the money spent on calendars, photographs, books, and movies as a measure of the value of this intermediate product. But the issue is not the value of their products but rather what is the relationship between the natural site or the endangered animal and their product. In particular, there are at least three questions to ask. (1) How much would the total value of secondary products be reduced if a species or natural area disappeared? (2) Is this secondary value already captured by direct use measures? (3) Does the very existence of these secondary products increase or decrease the need to keep the species alive?

If there were no costs to writing and producing a publication (book, photograph, or movie) about an endangered species, the species itself could claim the entire value of the publication. Without the species, the book could not have been written and society would have lost the opportunity to enjoy this good. In reality, of course, it costs a great deal to produce such publications. Without the species, the book would be lost but all the printer's, editors, and writer's time and materials would be freed to print another book. It is the difference in value from the nature book on this particular endangered species and the next best book which is the net contribution of the endangered species.

For example, it is evident that the photographs of Yosemite National Park by Ansel Adams are truly exquisite pieces of art. What if Yosemite had been destroyed before Adams had reached the valley? Would he have instead produced just as beautiful images of alternative sites? Would Yosemite be of less value if Adams had become a fashion photographer instead of producing his nature pictures? It is not at all clear that specific natural sites, in general, and individual endangered species, in particular, generate large net secondary benefits.

Suppose it were agreed that a particular species did contribute significantly to the net value of a book or movie. Is this net value already captured in the direct use measure of the site? The answer depends upon the technique used to measure the value of direct use. For example, if a contingent valuation approach were used and the author or cameraman was interviewed, the value such individuals should place on access to the site is equal to the value of the site in their enterprise. Similarly, if a travel cost technique is used and the artist's relatively high demand for access to the site is measured, this direct use measure could conceivably capture all of the net secondary benefits.

Perhaps the issue of secondary benefits is not that another good must be measured but rather that the measure of direct use must be sensitive to the fact that users creating secondary products may have unusually high

demand for these resources and should be carefully sampled. Thus the representative of a bird society collecting data for an annual lecture, the film maker creating a documentary on an endangered species, and the writer seeking direct contact with nature may all be high direct use demanders not because of their individual tastes but as representatives of a large clientele. It may therefore be important to carefully measure the direct use of these artistic producers to estimate a representative value of the resource.

Although it might appear from the above arguments that little importance is placed on the efforts of naturalists and others to reach the general public through movies, books, lectures, and photographs, such a conclusion should not be drawn. It is entirely plausible that these secondary products have a major beneficial impact on direct use. Certainly many visitors to wild and natural sites have been spurred on by books and documentaries of the very sites they choose to visit. The widespread increased direct use of natural sites in the United States is probably due at least in part to the growth in this country of a vast array of revealing and sensitive books, movies, and photographs of nature. This "inspirational value" on direct use, however, should be captured by intertemporal measures of direct use. As long as the trend in direct use is measured well, these secondary benefits should not be added to direct use measures. To complete my discussion of the role of secondary products on the need to keep species alive, I must introduce the concept of existence value. The discussion of whether or not secondary products increase or decrease existence value is discussed in the next section.

EXISTENCE VALUE

Existence value is a concept first raised by Krutilla (1967) in his often cited article on the benefits of conservation. Existence value is a payment individuals are willing to make to preserve a species (or natural area) which they have no intention of ever visiting. People supposedly obtain pleasure just from the knowledge that a creature or natural wonder is being preserved. Since it is independent of use, existence value clearly should be added to direct use as a measure of total preservation value.

There have been several attempts to measure existence value using contingent valuation methods. Schulze et al. (1983) estimated that 99% of the value of preserving visibility in southwest parks could be existence value. Walsh et al. (1984) find almost 20% of the value of preserving wilderness in Colorado is existence value. Finally, Greenley et al. (1981) estimate that 17% of the value of saving water quality in the South Platte River is existence value.

Although existence value is an intriguing concept, it is easy to be skeptical about the empirical results. After all, existence value is supposed to be completely devoid of potential use value. Is it possible these hypothetical questions were posed to eliminate all potential use? For example, Walsh et al. (1984) ask what percentage of total willingness to pay for wilderness preservation is due to the satisfaction from knowing that it exists as a natural habitat for fish, plants, wildlife, etc. At

first glance, it would appear this question is asking why the respondent would value going to a well known and visited site (because it is natural and not developed). Nowhere in the question is the caveat that the person must not visit the site, since even potential visits are reflected in measures of direct use. Greenley et al. (1981) assume that existence value is what nonusers are willing to pay to preserve water quality. Again there is no careful caveat to prevent direct use from entering the evaluator's judgment. It is highly likely that most, and possibly all, of the measured existence values are merely capturing a component of use value either for the respondent or on behalf of the respondent. As such, it is not at all clear that preservation value is the sum of use and existence value.

In addition to being difficult to quantify, there is reason to suspect that existence value may not even exist. After all, why would people value something with which they have no contact and for which they cannot anticipate contact. What difference would it make if it was not there? How would they even know it was not there when it ceased to exist? Clearly, if a lot of us possessed substantial existence value, it would give a shyster a lot of room to maneuver as he promised to preserve things but never did. Could we rightfully complain? Perhaps we could insist on third party verification that the creature remained. Would we pay a lot to hear a "yes," or would we want to know more. Perhaps a film of the creature and an occasional book would do. But if this is all we want to know of the creature's existence, what would stop the shyster from making several such films and books and then destroying the creature. Do the books and films become a substitute for the long dead creature. It appears that most people's notion of existence value is probably another form of use value, and probably should not be added to direct and secondary use value.

To test for existence value, it is necessary to eliminate potential use from consideration. For example, how much would you pay a millionaire who owned his own island to preserve some small fish in the middle of his property if it was clear that public access would never be granted to the area. Or, how much would you pay to protect an endangered mammal who lived safely on a radioactive island that could not even be approached for a thousand years by human beings. Casual empirical evidence suggests that true existence value is zero.

BEQUEST VALUE

Another source of the benefits of conservation listed by Krutilla (1967) is bequest value. Bequest value is how much an individual is willing to pay to have more capital or land devoted to conservation than alternative uses for his children to enjoy. Like existence value, this concept has been quantified with contingent valuation methods by Walsh et al. (1984) and Greenley et al. (1981). Bequest value was found to be about 18 and 14% of total preservation value in the two studies, respectively. "Bequest value is defined as the willingness to pay for the satisfaction derived from endowing future generations with wilderness resources" (Walsh et al. 1984).

As discussed in the introduction, the present value of use is the discounted value of all future use of the resource. It is very difficult to tell in what way bequest value differs from the string of discounted future benefits of users. Bequest value appears to be future user value called by a different name. Assuming it smells as sweet, it seems reasonable to continue using the concept of present value of use. If future use is properly incorporated into direct use measures, bequest value is redundant and should be ignored.

SCIENTIFIC VALUE

Many fields of science gain empirical knowledge through experiments made under artificial and controlled settings. It is evident, however, that nature itself performs experiments although without the care of controls. Although these natural experiments can be difficult to analyze because of the complexity of the settings, they provide opportunities which might otherwise be lost. For example, what would happen in the long run if one took a cold water mammal and placed it in warm water? Over 200 years, what behavioral and possible physiological changes would be adopted by the animal? Clearly, a controlled experiment along such lines of inquiry could be established but only at considerable cost and a great deal of patience. By studying the endangered monk seal in Hawaii, the answer to this question might be evident with just a modest program.

Endangered species may contain or provide valuable information which would forever be lost upon extinction. The scientific value of endangered species is the present value of all the knowledge the species could provide if it remained alive. Of course, to obtain knowledge from a species it must be studied. With 50,000 vertebrate species and over 2 million animals, it would help to know which species are likely to contain unique scientific information.

Many animals used in laboratory experiments are valuable because they, in one way or another, resemble man. They are also valuable because they are numerous, and so individuals are relatively expendable. This affords scientists additional latitude not permitted on human subjects. Clearly endangered species are unsuitable for this type of work because (perhaps for different reasons) they are just as valuable as humans. Such care has to be taken of their welfare that only gentle experiments can be performed. The gentler the disturbance of a creature, the more subtle his response, and so ever more sensitive measurements are needed on larger populations. Clearly, large population experiments are also difficult with endangered species.

A final note is that scientific value is not generally long lived. Once a species provides the key to a scientific issue, it is no longer useful for that purpose. Thus if an endangered species provides a new biochemical which is then produced by artificial means, it is no longer necessary to preserve the species. The scientific value of a species is the present value of all the clues the population has yet to provide. Once a discovery is made, the scientific value of the species is reduced. (A possible exception to this rule is the discovery that the species is ideal

for a line of experimentation. But as discussed earlier, endangered species are particularly inappropriate for this type of research because of their small numbers.)

CHEMICAL MINING

Wild species have been quite useful over the years to agriculture, medicine, and industry as a source of genetic material and organic compounds. Some 40% of the increase in American agricultural productivity has been attributed to improved genetic strains (Myers 1983). One of the most important tools of these geneticists is a large gene pool--fed by wild stocks. For example, a new strain of wild corn, Zea diploperennis, was recently discovered in the Mexican mountains. Not only is this wild corn resistant to several of the insects, fungi, nematodes, and bacteria which attack our current crops, but it is also a perennial. If this strain can be crossed with current corn into a successful perennial, it could save farmers millions of dollars in plowing and sowing costs.

Wild organisms have also been the source of almost half of the prescription drugs. The rosy periwinkle from tropical forests provides a cure to child leukemia, a Greek species of foxglove controls high blood pressure, a Caribbean sponge is effective against herpes encephalitis, and pufferfish produce compounds which block nerve transmissions, to name just a few of the sources of today's medical chemicals.

Industry, as well, borrows from the wild for many of its products. Tropical coral reefs provide stabilizers and emulsifiers which go into hundreds of products including plastics, polishes, waxes, detergents, etc. Organic chemicals from living plants, phytochemicals, could also serve as a substitute for petroleum-based chemicals if the price of crude oil gets too high.

The fact that man depends upon wild plants and animals is unquestionable. The issue, however, is whether all wild plants and animals should be preserved just because some species have become useful. Ecologists estimate there are 250,000 flowering plants and between 2.5 million and 12 million animal species. To argue that it would be foolish to wipe out all of these wild species is not to conclude that each species is valuable. Even a cursory screening of each of these species would probably be sufficient to identify which species is worth keeping. The probability of finding a valuable species from these vast pools is generally low, so that most wild species cannot be justified as a source of useful chemicals.

The application of chemical mining to endangered plants and animals has the additional problem of destroying individual specimens. Clearly, if the species population is small, it will be a poor source of large quantities of any chemical. Direct chemical mining of the species would either become a small renewable resource effort or a temporary and fatal nonrenewable resource collection. Direct chemical mining of an endangered species could be attractive only if the species could be made to grow quickly with help from man. Even here, the danger of taking the species from the wild to cultivated environment could lead to its accidental destruction.

The most likely avenue by which an endangered species could provide medical, agricultural, or industrial assistance is by being a source of information and not a source of direct chemicals. This perspective is discussed more fully in the previous section on scientific value.

In conclusion, most endangered species have no known chemicals which are of special value for agriculture, medicine, or industry. The few species which are clearly useful, like Zea diploperennis, can justify their existence solely as a source of new genetics or chemical material. However, even in these special cases, the fact that a wild species may be endangered (be close to extinction) lowers its potential value as a chemical source because experimentation is severely limited by the risk of destruction. Even the process of screening the plants for potential benefits must be curtailed by the possibility the search may itself lead to extinction. Thus, although an occasional species has direct and substantial value to agriculture, medicine, or industry, a collection of a thousand unknown but endangered species probably has a low expected value for chemical mining.

QUASI-OPTION VALUE

The concept of quasi-option value was first discussed formally by Arrow and Fisher (1974). They posed a situation where an irreversible decision is being contemplated under uncertainty. The decision could be made now or it could be postponed until more information was available (the uncertainty reduced). The value of waiting is quasi-option value. This concept clearly pertains to endangered species because once the decision for destruction is made it is irreversible. It is also true that the present value of the future streams of benefits of preservation and possible development is uncertain.

As Conrad (1980) notes, quasi-option value is the present value of more information. Because future benefits of information must be discounted, for quasi-option value to be large, we must be learning a lot about the benefits and costs of preservation in the near future. It is only if we can make better decisions about whether to preserve or destroy in the near future, that it pays to postpone making the decision. Given our slow accumulation of information about the long-term value of wild species and the high cost of collecting this information, quasi-option value will tend to be low.

In specific cases, however, quasi-option value could be sizable for a short period of time. For example, suppose a new species of animal or plant were discovered in an untraveled part of the world. A perfect example would be the discovery of Zea diploperennis in Mexico. Until experimentation with this corn is completed, it would probably be foolish to wipe out its habitat. The flow of information coming about the potential usefulness of this species clearly warrants postponing its destruction. Quasi-option value, when it exists, will tend to be short lived. The very process of reducing the uncertainty about the benefits of a species, the source of the quasi-option value, eventually leads to a more or less certain choice. At this point, quasi-option value falls to zero, and the

species is either kept or destroyed based on its known other benefits and costs.

It is also clear that ecosystems or species which do not have sufficient potential to attract research interest will not generate enough new information to warrant a positive quasi-option value. As a meaningful empirical concept, quasi-option value only applies to species which are of current research interest.

OPTION VALUE

Although quasi-option value and option value have similar names and deal with questions of uncertainty, they are distinct concepts. As just discussed, quasi-option value is concerned with intertemporal decisions under uncertainty which are irreversible. Option value, in contrast, is a static concept concerned with valuing projects under uncertainty. As first vaguely expressed by Weisbrod (1964), option value was described as what people would be willing to pay above consumer surplus simply for the option (or chance) to have a good or service. It was widely felt by environmental economists (Cichetti and Freeman 1971; Krutilla and Fisher 1975), that the option value for conservation areas including rare species would tend to be positive. Thus, in addition to the expected value of all the utilitarian benefits listed in this paper, there would be an added "risk premium" made in favor of preservation.

Subsequent research by Schmalensee (1972), Anderson (1981), Graham (1981), Bishop (1982), Mendelsohn and Strang (in press) has shown that option value is not the same as a financial option. With a financial option, a purchaser has the right to buy a good at a specified price in the future. If the price of the good becomes higher than the specified price, the purchaser can exercise his option and a profit. If the price of the good ends up being lower than the specified price, the purchaser of the financial option simply lets his option expire. Option price, in contrast, requires the purchaser to buy the good at the specified price. If the price of the good becomes higher, option price resembles the financial option because the financial option will be exercised. If the price of the good is lower than the specified price, however, the purchaser of option price must buy the good at the specified price. Unlike the financial option, the purchaser must always purchase the good at the specified price. Because the actual price of the good may be lower than the specified price, option price may lock the purchaser into a losing position.

Expected consumer surplus is the measure of what people would pay for the actual service or good they receive. The consumer surplus payment consequently varies with the level of service. The option price payment, in contrast, is the same regardless of the actual level of service. Let us contrast these two measures in a simple example. Suppose people's tastes were such that they would be willing to pay a dollar for each whale they see during a single boat trip. Thus, if no whales are sighted, their willingness to pay would be zero. Under expected consumer surplus, they would pay nothing but under option price they would have to pay a specified price. Similarly, suppose they saw 10 whales (and the average on all trips

is 5), under consumer surplus they would have to pay $10 but under option price they would have to pay only the specified price. Thus the difference between expected consumer surplus and option price is the method of payment. Under consumer surplus, you always pay for what you get. Under option price, you always pay the same amount, whether you get it or not.

Option value is a relevant concept because many public projects are financed from general tax revenues. Thus, one pays a single amount for each park and each species regardless of the actual value of the good. In contrast, the park tends to be valued according to its expected consumer surplus, that is, the actual value to users. Thus our measure of value is inconsistent with our measure of payment. The measure of value is expected consumer surplus, the method of payment is option price. If option price exceeds consumer surplus, public conservation projects should be given a risk premium benefit. If consumer surplus exceeds option price, public conservation projects should be assigned a risk premium cost.

Because option price freezes the purchaser into buying the good at one price, it is not necessarily greater than expected consumer surplus. In fact, option price can be smaller or greater than expected consumer surplus. More importantly, the difference between the two measures relates to the absolute value of the good and subtle changes in the marginal utility of income. As Freeman (1984) has shown, in most circumstances, this difference is likely to be small. As first recommended by Schmalensee (1972), it seems reasonable to accept expected consumer surplus as a close approximation to the ideal measure in an uncertain world.

In contrast to the results of these theoretical inquiries, Greenley et al. (1981), Brookshire et al. (1983), and Walsh et al. (1984) using contingent valuation methods all conclude that option value, the difference between option price and expected consumer surplus, is large and a significant fraction of preservation value. The relevance of these findings, however, is seriously undermined by the definition these authors use for option value. Walsh et al. (1984) define option value as the annual payment required to retain the option of possible future recreation use. This clearly is not option value at all but rather just option price. In the Walsh et al. (1984) paper, option price is clearly less than expected value. In Greenley et al. (1981), option value is defined as what the user would be willing to pay for perfect information about a site next year. Not only is the question vague because the initial uncertainty is not specified, but it is actually a definition of quasi-option value and not option value at all.

On a more theoretical level, Conrad (1980) charges that option value is just the value of perfect information. Option value is clearly positive if this is correct. Conrad, however, has simply redefined option value. He defines an option as the opportunity to delay an irreversible decision until perfect information is available. This is a very different notion from paying a constant price for a good regardless of the true state of nature. Conrad confuses option value with quasi-option value and correctly deals only with the latter.

Another source of confusion is the summary article on option value by Bishop (1982). After an excellent review of the past literature, Bishop attempts to extend the literature by discussing supply side uncertainty. He comes to the conclusion that uncertainty about supply side parameters leads to a positive option value. In a separate article Smith (1983) attempts a similar extension using Cook and Graham's (1977) model of insurance against irreplaceable assets. Smith argues that option value is positive whenever the good in question is irreplaceable.

Clearly, both Bishop's and Smith's arguments could apply to endangered species since both supply uncertainty and irreplaceability are characteristics of endangered species. Both arguments, however, are faulty for different reasons. Bishop's supply side argument raises a special case where option value would be positive. There is little reason to believe, however, that in general people would prefer to make a constant payment for a natural area of variable quality (option price) rather than a payment which varied with the quality of the site (expected value). If the marginal utility of income is positively related to the realized benefits (quality) of the site, option value will be negative. Smith, in turn, confuses option price and Cook and Graham's ransom payment. A ransom payment is what an individual would pay for a good in a certain world. Option price, in contrast, is a certain payment for a good in a random world. The model Smith constructs in his paper implies that the benefits of a project are the same regardless of the outcome of an uncertain world. In such cases, option price and expected value of consumer surplus are also the same. Despite this, Smith asserts he shows option price is larger than expected consumer surplus. The confusion begins, but may not be limited, to the difference between a ransom payment and option price.

A final line of argument raised for a risk premium uses a different notion than option value. For completeness, however, it deserves discussion. Bishop (1978) argues that endangered species should be given a risk premium as part of a game theory model. In Bishop's model, society can or not attempt to protect some endangered species. If it does not protect the species, society might lose it and receive loss y. If it does protect the species, he argues that the worst that can happen is that the protection expense x was unnecessary. As long as $y > x$, the minimax strategy minimizing the worst case, is to protect the species. Bishop pushes this argument further. The potential benefits from the species may have a broad distribution. Evaluating y as the highest possible value of the endangered species, it is likely to be greater than x, the certain cost of foregoing development. Consequently, all endangered species should be preserved unless their existence requires excessive costs.

As Bishop himself notes, this is an entirely conservative approach. Even though the species may have a 1 in 10 million chance of providing benefits, the argument asks us to treat the species as though it provided benefits for certain. The minimax strategy is fine if the worst case is likely to occur but it is much too rigid an approach if the worst case is a rare event. Life would be very tedious if our sole aim was to avoid all the minute chances of having an accident. Clearly the likelihood of a bad accident should be included in our decision making calculus.

A second point not recognized by Bishop is that the worst possible case is not extinction at all. The worst case is that we spend x on preservation and yet the species goes extinct anyway. Since there is no expenditure which will guarantee survival, our best minimax strategy is to not preserve anything regardless of its value.

In conclusion, it appears that option value is small and may be either positive or negative. Given that we have few means available to determine option value, the sensible approach seems to be to ignore it since it does not bias our decisions. Consequently, the appropriate measure of the value of endangered species given uncertainty is the expected value of all benefits.

NONUTILITARIAN BENEFITS

Most of the discussion of endangered species benefits concerns how plants and animals may be useful to man. The underlying notion is that it may be in man's self-serving interest to maintain many species. Some philosophers naturally object to this homocentric viewpoint of nature. Some people do not believe nature exists just for man's pleasure. In fact, Stone (1972) argues that all of nature should be given rights (legal standing) to defend its interests against man.

Existence is primarily a function of adequate resources. Every species needs a certain amount of the correct habitat to survive. The more of that habitat, the higher the probability of survival. Survival can consequently be viewed as an allocation of habitat (resources) problem. Given the total resources of the world, how should they be allocated among species? The problem of survival among species closely resembles issues of income or wealth distribution among people.

Borrowing from Rawls (1971), let's try to determine the optimal allocation of habitat across species. The discussion in the rest of this paper has focused upon how man would like the resources allocated. In this section, we would like to expand the number of voters to include other species. Rawls suggests that one way to think about a fair distribution is to step through a "veil of ignorance." Suppose we did not know that we would be the dominant species. In fact, suppose one could be anywhere in the distribution of species. What allocation of resources across species would one vote for?

Rawls himself argues for a minimax solution. We should try to minimize the worst possible case by making the worst off species as well off as possible. The argument resembles Bishop's (1978) plea to protect all species unless the cost is excessive. Although the definition of excessive cost remains vague, the implication of these arguments is that man (and plants and animals cultivated by man) ought to return substantial habitat to creatures man has little interest in. There should be substantially less commercial forest, agricultural land, grazing acreage, developed land, and probabaly much fewer people. Perhaps only 1% or fewer of the world's population of humans should be allowed to remain.

As discussed by Bishop (1978), the minimax strategy is exceptionally conservative. Why not take a chance that one could become extinct rather than have to share all resources almost equally across species. Almost equal sharing across some 2 to 12 million animal species would almost surely leave most species permanently in a dire subsistence state. Many people would probably prefer to take a chance of dying to get a better life for them and their children rather than having the certainty of permanent poverty. Extinction may be an acceptable risk if the potential rewards to the remaining species are large enough.

Another issue of serious import is how would all the other animals vote. Is man the only animal concerned with its own interest, whereas, the rest of nature maintains a perfect balance? Does nature abound with examples of altruistic behavior across species? I believe there are very few examples where animals have reduced their own welfare consciously to protect other species. Most animals kill as much as they want to eat. They don't willingly go hungry because their food source is weak and needs replenishment. If predators go hungry, it is because they cannot find their source prey, not because they are sorry for them. The law of nature appears to be the law of survival. The law of survival says the dominant animal acts in his self interest. The behavior of most animals would suggest that they would vote for a distribution of resources determined by the interests of the dominant animal. Far from protecting all species, this belief is a foundation for a homocentric utilitarian approach. Man, as the dominant animal, should work to maintain species only if they are valuable to mankind.

CONCLUSIONS

This paper reviews the literature written about conservation and endangered species. The literature identifies nine sources of benefits that living resources might provide man. It is argued that existence value, bequest value, and secondary benefits are redundant and capture benefits measured elsewhere. Other benefits which might be large for some wild species are probably near zero for endangered species because of their small populations. These benefits include direct consumptive use, indirect benefits, scientific information, chemical mining, and quasi-option value. It is further argued that option value could be either positive or negative, is hard to measure, and is probably small. Thus, despite the considerable uncertainty surrounding measurements of the benefits of species preservation, the best approach is to value benefits at.their expected value. The major conclusion of the paper is that nonuse values of endangered species are near zero and irrelevant. The focus of empirical work should be upon measuring the use values of endangered plants and animals.

The major benefit of maintaining endangered species lies in nonconsumptive direct use. It is what people are willing to pay to interact with the species in its native habitat. It is the sum of these payments across all users--tourists, hikers, naturalists, writers, moviemakers, etc.--which is the social value of the resource. Projecting this stream of benefits indefinitely into the future and taking its present value yields the social value of each species.

If this hypothesis is correct, that species ought to be preserved because of their nonconsumptive direct use, it gives new perspective to the optimal management of wild species. An animal which people enjoy seeing such as a seal, whale, elk, or buffalo should be protected whether or not it has a small population. The value of the species is not just a function of the size of its population or probability of extinction, but also a question of its appeal. Surely some animals are valuable because they are almost extinct, but some species so closely resemble surviving species that their loss would hardly be noticed. As a point of evidence supporting this notion, even biologists are only aware of a small fraction of the species which go extinct each year. Typical users are probably aware of even fewer of the losses. Some species are clearly worth preserving more than others.

Second, protection of endangered species should not be accomplished to the exclusion of all nonconsumptive use. Surely, if the primary value of maintaining a whale population is the benefits achieved by onlookers, it would be foolish to overprotect the whale by banning all approaches by man. Any overzealous regulation which neutralizes the reason for keeping the animal alive is hardly in the interest of society or the animal. Clearly, one should look for a balance between preserving the animal and maintaining use. Similarly, if the benefits of a species are in viewing rather than scientific information, tour boats should be given preference of access over scientific experimenters.

Third, although the tone of this paper is highly critical of the multiplicity of specialized benefits supposedly provided by endangered species, it is not argued that preservation benefits are likely to be smaller than heretofore expected. It could well be that correct measurement of nonconsumptive direct use will reveal that the preservation value of many endangered species is, in fact, higher than is now expected.

Fourth, nonconsumptive direct use can be measured and evaluated. Contingent valuation, multiple site travel cost, and hedonic travel cost are existing techniques which can be brought to bear on measuring the value of direct use. If, in fact, preservation value is nothing but nonconsumptive use value, then the benefits of preserving individual endangered species can be measured.

Fifth, the benefits and costs of preserving endangered species should be carefully weighed. Current laws rigidly demand all endangered species be preserved. Although, in practice, the administration of this law has been far more flexible than the law itself, Harrington (1981) and Miller and Menz (1979) are correct in their call for a better allocation of resources towards plant and animal protection. The expenditure of a dollar to save a small irrelevant fish could well be the dollar that could have saved an eagle, whale, or brown bear. Society can ill afford to throw its resources carelessly at vanishing habitats or endangered species.

ACKNOWLEDGMENTS

I wish to thank Samuel G. Pooley, Tim Gerrodette, and Karl C. Samples for their stimulating comments and encouragement.

LITERATURE CITED

Anderson, R.
1981. A note on option value and the expected value of consumer's surplus. J. Environ. Econ. Manage. 8:187-191.

Arrow, K. J., and A. Fisher.
1974. Environmental preservation, uncertainty, and irreversibility. Q. J. Econ. 88:312-319.

Bachmura, F.
1971. The economics of vanishing species. J. Nat. Resour. 11:647-692.

Bishop, R.
1978. Endangered species and uncertainty: The economics of a safe minimum standard. Am. J. Agric. Econ. 60:10-18.

1982. Option value: An exposition and extension. Land Econ. 58:1-15.

Brookshire, D., L. Eubanks, and A. Randall.
1983. Estimating option prices and existence values for wildlife resources. Land Econ. 59:1-15.

Brown, G., and R. Mendelsohn.
In press. The hedonic travel cost method. Rev. Econ. Stat.

Cichetti, C., and A. M. Freeman.
1971. Option demand and consumer surplus: Further comment. Q. J. Econ. 85:528-539.

Clark, C.
1973. Profit maximation and the extinction of animal species. J. Political Econ. 81:163-173.

Conrad, J.
1980. Quasi-option value and the expected value of information. Q. J. Econ. 94:810-820.

Cook, P., and D. Graham.
1977. The demand for insurance and protection: The car of irreplaceable commodities. Q. J. Econ. 91:143-156.

Cropper, M., D. Lee, and S. Pannu.
1979. The option extinction of a renewable natural resource. J. Environ. Econ. Manage. 6:341-349.

Freeman, A. M., III.
1984. The sign and size of option value. Land Econ. 60:1-13.

Graham, D.
1981. Cost benefit analysis under uncertainty. Am. Econ. Rev. 71:715-725.

Greenley, D., R. Walsh, and R. Young.
1981. Option value: Empirical evidence from a case study of recreation and water quality. Q. J. Econ. 66:657-673.

Harrington, W.
1981. The endangered species act and the search for balance. J. Nat. Resour. 21:71-92.

Krutilla, J. V.
1967. Conservation reconsidered. Am. Econ. Rev. 57:777-786.

Krutilla, J. V., and A. C. Fisher.
1975. The economics of natural environments: Studies in the valuation of commodity and amenity resources. John Hopkins Press, Baltimore, Md.

Mendelsohn, R., and W. Strang.
In press. Cost benefit analysis under uncertainty: A comment. Am. Econ. Rev.

Miller, J.
1978. A simple economic model of endangered species protection in the United States. J. Environ. Econ. Manage. 8:292-300.

1981. Irreversible land use and the preservation of endangered species. J. Environ. Econ. Manage. 8:19-26.

Miller, J., and F. Menz.
1979. Some economic considerations for wildlife protection. South. Econ. J. 45:718-729.

Myers, N.
1983. By saving wild species we may be saving ourselves. Nat. Conserv. News. 33:7-13.

Plourde, C.
1975. Conservation of extinguishable species. J. Nat. Resour. 15:791-798.

Porter, R.
1982. The new approach to wilderness preservation through benefit cost analysis. J. Environ. Econ. Manage. 9:59-80.

Rawls, J.
1971. A theory of Social justice. Harvard Univ. Press. Cambridge, Mass.

Schmalensee, R.
1972. Option demand and consumer's surplus: Valuing price changes under uncertainty. Am. Econ. Rev. 62:813-824.

Schulze, W., D. Brookshire, E. Walter, K. MacFarland, M. Thayer, R. Whitworth, S. Dean-David, W. Maln, and J. Molenar.
1983. The economic benefits of preserving visibility in the national parklands of the southwest. J. Nat. Resour. 23:149-173.

Sinn, H.
1982. The economic theory of species extinction: Comment of Smith. J. Environ. Econ. Manage. 9:174-198.

Smith, V. K.
1983. Option value: A conceptual overview. South. Econ. J. 49:654-668.

Stoll, J., and L. A. Johnson.
1984. Concepts of value, nonmarket valuation, and the care of the whooping crane. Texas Agric. Exp. Stn. Tech. Art. No. 19360.

Stone, C.
1972. Should trees have standing? Toward legal rights for natural objects. South. Calif. Law Rev. 45:450-501.

Walsh, R., J. Loomis, and R. Gillman.
1984. Valuing option existence, and bequest demand for wilderness. Land Econ. 60:14-29.

Weisbrod, B.
1964. Collective consumption services of individual consumption goods. Q. J. Econ. 77:71-77.